SUGGESTION CONCERNING THE NOMENCLATURE OF HEAT CAPACITY.

By Theodore William Richards.

Received December 19, 1900. Presented January 9, 1901.

The word "calorie" has come to have so many significations as to have lost definite meaning, unless qualified by an explanatory phrase. For this unfortunate condition of affairs, which is due primarily to the variability of the specific heat of water, the best remedy seems to me to be the general use of a new standard for the measurement of heat capacity.

The growing tendency to refer all energy measurements to the centimeter-gram-second basis makes it fitting that heat also should be measured directly in these terms. It is not unusual to do this, as far as heat-energy is concerned; but the practice is hampered by the fact that the standards of temperature and heat-capacity have no rational relation to the so-called absolute units. One calorie equals about 42,000,000 ergs, or 4.2 joules. Would it not be a convenience to arrange the standards of heat measurement so that the direct product of heat capacity and change of temperature would be expressed in joules? Nearly ten years ago Ostwald pointed out some of the advantages of such a practice,* but the suggestion does not seem to have received the attention which it deserves.

One way to accomplish the desired result would be to construct a new scale of temperature with degrees about $\frac{10}{42}$ the size of the present centigrade degrees, and to retain the specific heat of water at a definite temperature as the unit of capacity. This course retains one of the disadvantages of our present system, and is open to several other objections, the chief of which would be the variability of the degree with each new measurement of the value of the mechanical equivalent.

Another obvious course is to retain the centigrade degree, measured by the hydrogen or helium thermometer, as final, and to choose for the unit of capacity that capacity which is warmed 1 degree centigrade by

* Zeitschr. phys. Chem., **9**, 577 (1892).

1 joule (1 watt-second, or 10^7 ergs). Here the unit of capacity will vary with each new increase in accuracy in the determination of the mechanical equivalent; but capacity is a less tangible dimension than temperature, and its variation would cause less instrumental confusion.

This convenient unit of capacity would be nearly represented by the heat capacity of a gram of magnesium at low temperatures (—50°), or that of a gram of aluminum at high temperatures (about 290° C.). At ordinary temperatures an alloy of zinc and magnesium containing about 5.5 per cent of zinc would probably have the desired capacity.

Specific heats are frequently spoken of in terms of *calories*, thus confounding heat capacity with energy. As a matter of fact, the idea of specific heat is mathematically nothing but a simple ratio like specific gravity, — a pure number without physical dimensions. The unit suggested here is rather to be compared with *density*; it has the definite dimension of energy divided by temperature.

It seems to me that a name for this unit would greatly assist the beginner to discriminate between energy and capacity. Would not the name "mayer," in honor of the unfortunate Julius Robert Mayer, one of the discoverers of the first law of energy, be a convenient and fitting term for the centimeter-gram-second ÷ centigrade unit of heat capacity?

On this basis the heat capacity of a gram of water at twenty degrees centigrade is about 4.181 mayers, and that of a gram of liquid mercury is $.0333 \times 4.18 = 0.139$ mayers. The gas constant becomes 8.32 mayers, if the atomic weight of oxygen is taken as 16; and the Dulong and Petit constant or gram-atomic heat capacity becomes about 26.5 mayers on the same basis. These numbers are all of convenient magnitude. For larger values, such as the heat capacities of solutions used in thermochemistry, the kilomayer is a convenient unit. For instance, the capacity of $HCl + 100\ H_2O$ is 7.41 kilomayers, while that of a similarly dilute solution of 40 grams (a mol) of sodic hydroxide is 7.42 kilomayers. The solution produced by mixing these two has a capacity of 15.02 kilomayers. In order to show how convenient these figures are as a basis of calculation, it is only necessary to point out that this difference of 0.19 kilomayer between the capacities of factors and product indicates that the heat of neutralization will vary 0.19 kilojoule * for each degree of tem-

* Ostwald has pointed out the convenience of the *kilojoule* as a unit in thermochemistry, in the latest edition of the "Grundriss der allgemeinen Chemie." It seems to me that it would be well to represent this useful unit by kj., in analogy to km. and kg., rather than by J., which might be mistaken as an abbreviation for joule. Kilomayer may be abbreviated to kmy.

perature, according to the well-known equation $C_T - C_T = \frac{U_{T'} - U_T}{T' - T}$, where capacities are represented by C, heats of reaction by U, and temperatures by T.

Since entropy has the dimensions of heat capacity, it too may be measured in mayers. This application of the new name may lend concreteness to an idea which has been to some a stumbling-block.

The greatest gain to be derived from the consistent use of the "absolute" unit of heat capacity is to be found in the field of electrochemistry. Here even technical men have used for several years the admirable system of units resting upon the centimeter-gram-second basis. The increasing use of both the thermodynamic and osmotic equations of electrochemistry will make the ready application of these units to heat and gas energy almost a necessity.

CAMBRIDGE, MASS., October 31, 1900.